DRAINAGE LETTER REPORT

for

LOT 23, RED ROCK RESERVE
4619 REDSTONE RIDGE ROAD
MONUMENT, CO 80132

Prepared for:

Hughes Family Revocable Living Trust
4619 Redstone Ridge Road
Monument, CO 80132

May 7, 2026

Prepared by:

19 E. Willamette Avenue
Colorado Springs, CO 80903
(719)-477-9429
www.jpsengr.com

JPS Project No. 022603
PCD File No.: VR26__

DRAINAGE STATEMENT

Engineer's Statement:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for liability caused by negligent acts, errors or omissions on my part in preparing this report.

_____

John P. Schwab, P.E. #29891

Developer's Statement:

I, the developer, have read and will comply with all of the requirements specified in this drainage report and plan.

By:

_____

Printed Name: Hughes Family Revocable Living Trust Date
4619 Redstone Ridge Road, Monument, CO 80132

El Paso County's Statement

Filed in accordance with the requirements of the El Paso County Land Development Code, Drainage Criteria Manual, Volumes 1 and 2, and Engineering Criteria Manual as amended.

_____

Joshua J. Palmer, P.E. Date
County Engineer / ECM Administrator

Conditions:

JPS ENGINEERING
19 E. Willamette Avenue
Colorado Springs, CO 80903
(719)-477-9429
www.jpsengr.com

RED ROCK RESERVE – LOT 23
DRAINAGE LETTER REPORT

This Drainage Letter Report has been prepared in support of the proposed Easement Vacation for a portion of the existing rural residential lot at 4619 Redstone Ridge Road in the Palmer Lake area of northern El Paso County, Colorado. The subject property is a 2.75-acre lot platted as Lot 23, Red Rock Reserve Subdivision. The property is developed with an existing residence on the north side of the lot. The Owner (Hughes Family Revocable Living Trust) is currently proposing to vacate a portion of the platted drainage easement along the south side of the property to allow for construction of a second residence in the southeast corner of the lot.

JPS Engineering prepared the "Final Drainage Report for Red Rock Reserve Subdivision" dated March 27, 2006 (approved April 21, 2006). Lot 23 lies within Drainage Basin A1 as depicted on the approved subdivision drainage plan, and surface drainage from this lot flows southeasterly to the existing roadside ditch along the southwest side of Redstone Ridge Road. Basin A1 receives off-site drainage from Basin OA1 south of the property, and the combined flows ultimately drain to Detention Pond A at the east boundary of the subdivision. A wide "no-build drainage easement" was originally platted along the south side of Lot 23 based on the existing drainage swale flowing across the property.

The approved FDR identified developed flows of Q_5 = 7.6 cfs and Q_{100} = 16.4 cfs for Basin A1. For site-specific drainage analysis, the off-site area contributing to Lot 23 has been delineated as Basin OA1.1 on the enclosed "Lot 23 Off-site Drainage Plan." The on-site areas within Lot 23 have been delineated as Basin A1.1 (southwest side of lot) and Basin A1.2 (northeast portion of lot). As detailed in the hydrologic calculations in Appendix B, drainage from Basin OA1.1 and A1.1 combines at Design Point #1, with peak flows calculated Q_5 = 3.2 cfs and Q_{100} = 13.2 cfs. Developed flows at Design Point #A1.2 are calculated Q_5 = 1.1 cfs and Q_{100} = 4.5 cfs.

JPS Engineering has reviewed the preliminary site plan for the proposed second residence, and we have provided input on the site layout and drainage scheme for the proposed residence. Based on our recommendations, the site plan includes proposed drainage swales to ensure positive drainage along the north and west sides of the new residence, along with proposed grass-lined drainage channels to safely convey the upstream drainage around the south and east sides of the new residence. Hydraulic calculations for the proposed drainage channels are enclosed in Appendix C. Based on the relatively steep slopes across this lot, erosion control blanket lining has been specified for the proposed grass-lined drainage channels.

Based on the proposed site plan for this lot as depicted on the enclosed "Sheet D1.1: Lot 23 Developed Drainage Plan," we recommend vacation of the existing drainage easement encompassing most of the south side of the property, and dedication of new easements following the proposed drainage channels along the south and east sides of the new second residence.

We recommend that builders and property owners adhere to the following general guidelines for proper site grading and drainage:

- Provide positive drainage away from structures and account for potential cross-lot drainage impacts within each lot.
- Implement and maintain proper control measures for erosion and sediment control to provide protection of downstream properties and facilities.

In summary, we recommend a vacation and revision to the platted drainage easements along the south side of Lot 23 to allow for construction of the proposed second residence as depicted on the attached "Lot 23 Developed Drainage Plan."

Sincerely,
JPS Engineering, Inc.

John P. Schwab, P.E.

APPENDIX A

EXCERPTS FROM PREVIOUS DRAINAGE REPORT

FINAL DRAINAGE REPORT
FOR
RED ROCK RESERVE SUBDIVISION

VERSION: 4th
DATE: 4/2-/06

Prepared for:

Red Rock Reserve Development Company
17430 Lamplight Drive
Monument, CO 80132

October 5, 2005
Revised November 14, 2005
Revised December 30, 2005
Revised March 27, 2006

Prepared by:

JPS ENGINEERING

19 East Willamette Avenue
Colorado Springs, CO 80903
(719)-477-9429
(719)-471-0766 FAX

JPS Project No. 070401

JPS ENGINEERING

RED ROCK RESERVE
FINAL DRAINAGE REPORT
EXECUTIVE SUMMARY

A. Background

- Red Rock Reserve is a proposed low-density residential subdivision of a 67.9-acre parcel located south of Palmer Lake in northwestern El Paso County.
- The development plan consists of 23 residential lots with 2-1/2-acre minimum lot sizes.

B. General Drainage Concept

- Developed drainage within the site will be conveyed through paved streets with roadside ditches and culverts, as well as grass and riprap-lined channels through open space areas following historic drainage patterns through the site.
- Developed runoff from Red Rock Reserve will flow in a northeasterly direction, ultimately feeding into the main channel of Monument Creek. Impacts of developed flows from the proposed subdivision will be mitigated by upgrading two existing stock ponds at the easterly boundary of the project to serve as stormwater detention ponds.

C. Drainage Impacts

- The proposed detention ponds will release historic flows at the property boundary, ensuring no increase in developed flow to downstream properties.
- Drainage facilities within public road rights-of-way will be designed and constructed to El Paso County standards, and dedicated to the County for maintenance.
- Drainage facilities such as swales running through private lots will be owned and maintained by the private lot owners or homeowners association. The proposed stormwater detention ponds will be privately owned and maintained by the HOA.

DRAINAGE STATEMENT

Engineer's Statement:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the City/County for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

COLORADO REGISTERED JOHN P. SCHWAB 29891 PROFESSIONAL ENGINEER

4/19/06

John P. Schwab, P.E. #29891

Developer's Statement:

I, the developer have read and will comply with all of the requirements specified in this drainage report and plan.

By: _____ 4/12/06

Printed Name: William F. Herebic, II Date

Title: VP / Sec. / Treas.

Red Rock Reserve Development Company
17430 Lamplight Drive
Monument, CO 80132

El Paso County's Statement

Filed in accordance with Section 51.1 of the El Paso Land Development Code, as amended.

_____ 4-21-06

John A. McCarty, P.E., Director / County Engineer Date

Conditions:

I. GENERAL LOCATION AND DESCRIPTION

A. Background

Red Rock Reserve Subdivision is a proposed residential development located in the Forest View Acres area of northwestern El Paso County, Colorado. The Red Rock Reserve parcel (El Paso County Assessor's Number 71000-00-371) is located at the west end of Red Rock Ranch Road, south of the Town of Palmer Lake, as shown in Figure A1 (Appendix A). Red Rock Reserve Subdivision will consist of 23 low-density residential lots (2.5-acre minimum size) on a 67.9-acre parcel. The proposed lots will be provided with central water service from the existing Forest View Acres Water District (FVAWD). Wastewater service for the proposed lots will be provided by individual septic systems.

B. Scope

This report will provide a summary of site drainage issues impacting the proposed development. The report will analyze impacts from upstream drainage patterns, site-specific developed drainage patterns, and impacts on downstream facilities. This report is based on the guidelines and criteria presented in the El Paso County Drainage Criteria Manual. This report is intended to fulfill the County requirements for a "Final Drainage Report (FDR)" submitted with the final plat for the project.

C. Site Location and Description

The Red Rock Reserve parcel is located in Section 8, Township 11 South, Range 67 West of the 6th Principal Meridian. The site lies ¾-miles south of the Town of Palmer Lake and ¼-mile east of Pike National Forest. State Highway 105 (SH105) is located approximately 1-mile northeast of the parcel. The site is currently a vacant forest and meadow tract, with the exception of existing utility facilities serving the Forest View Acres Water District. The parcel is currently zoned RR-3 (rural residential, 5-acre lots). The proposed development will consist of re-zoning the parcel to RR-2 (rural residential, 2.5-acre lots).

Access to Red Rock Reserve will be provided by extension of Red Rock Ranch Road west from its current termination near Spruce Road. Subdivision improvements will include paving of new public roadways through the site, as well as grading, drainage, and utility service improvements for the proposed residential lots. Internal roads will be constructed to El Paso County "rural residential" standards, with 28-foot asphalt pavement widths and 2-foot gravel shoulders.

The parcel is bordered by vacant forest and meadow areas to the north and northwest. The existing Forest View Estates Subdivision (within Town of Palmer Lake limits) borders this parcel to the east and northeast. The existing Red Rock Ranch Subdivision (Zoned RR1- ½-acre minimum lots) borders this parcel to the south. Elevations within the site range from approximately 7,200 feet to 7,430 feet above mean sea level.

Drainage patterns in this area generally flow northeasterly towards the major drainage channel of Monument Creek. The parcel includes hilly terrain rising to the national forest property at the westerly boundary of the site, which has steeper grades ranging from 3:1 to 2:1. Average grades across the site range from 2 to 10 percent. Existing vegetation consists of heavily forested areas with evergreen trees and scrub oak, and small meadow areas with prairie and upland grasses.

D. General Soil Conditions

According to the Soil Survey of El Paso County prepared by the Soil Conservation Service, on-site soils are comprised primarily of Type 93, "Tomah-Crowfoot" loamy sands (see Figure A2 and Appendix B). These soils are classified as hydrologic soils group "B," with moderately rapid permeability, medium surface runoff characteristics, and a moderate hazard of erosion. A small area at the easterly site boundary is comprised of Type 65, "Perrypark" gravelly sandy loam. These soils are classified as hydrologic soils group "B," with moderate permeability, medium surface runoff characteristics, and slight to moderate hazard of erosion.

Soils in the off-site drainage basins west of this site are classified as Type 38, "Jarre-Tecolote" complex and Type 77, "Rock outcrop-Coldcreek-Tolman" complex. The "Jarre-Tecolote" complex soils are classified as hydrologic soils group "B," with moderate permeability, medium to rapid surface runoff characteristics, and moderate to high hazard of erosion. The "Rock outcrop" complex soils are classified as hydrologic soils group "B/D," with moderate permeability, medium surface runoff characteristics, and moderate hazard of erosion.

E. References

City of Colorado Springs & El Paso County "Drainage Criteria Manual," revised October 12, 1994.

CDOT, "CDOT Drainage Design Manual," July, 1995.

El Paso County "Subdivision Criteria Manual," June, 1981.

FEMA, Flood Insurance Rate Map (FIRM) Number 08041C0260-F, March 17, 1997.

JPS Engineering, Inc., "Preliminary Drainage Report for Red Rock Reserve Subdivision," March 22, 2005.

Leigh Whitehead & Associates, Inc., "Preliminary Drainage Report and Plan for Raspberry Ridge Subdivision," March, 2001 (preliminary report; not approved by El Paso County).

USDA Natural Resources Conservation Service, "Soil Survey of El Paso County Area, Colorado," June, 1981.

II. DRAINAGE BASINS AND SUB-BASINS

A. Major Basin Description

The proposed development lies within the Raspberry Mountain Drainage Basin (FOM 05600) as classified by El Paso County. Drainage from this basin generally flows northeasterly towards the main channel of Monument Creek.

B. Floodplain Impacts

The northeast corner of the project site is located approximately ½ mile from the 100-year floodplain limits for Monument Creek delineated by the Federal Emergency Management Agency (FEMA). The floodplain limits in the vicinity of the site are shown in Flood Insurance Rate Map (FIRM) Number 08041C0260-F, dated March 17, 1997 (see Figure A3).

C. Sub-Basin Description

The existing drainage basins lying in and around the proposed development are depicted in Figures EX1 and EX2 (Appendix A). Four off-site basins contribute surface runoff from the areas on the south and west sides of this parcel. The existing on-site topography has five identifiable drainage basins conveying overland surface drainage towards the north and east boundaries of the site. The natural drainage patterns will be impacted through development by site grading and concentration of runoff along subdivision street ditches. Developed runoff will generally continue to follow historic paths.

III. DRAINAGE DESIGN CRITERIA

A. Development Criteria Reference

No drainage basin planning study has been completed for the "Raspberry Mountain Drainage Basin." In March, 2001, Leigh-Whitehead prepared a "Preliminary Drainage Report" for a previous "Raspberry Ridge Subdivision" proposal, comprising a larger area of approximately 108 acres which included adjacent property north of this site. The previous 2001 Preliminary Plan submittal was withdrawn and never approved by El Paso County. Calculations in this report are generally consistent with the previous unapproved report. Minor differences in calculations can be attributed to differences in composite runoff coefficient calculations. The "Preliminary Drainage Report" by JPS Engineering was approved by El Paso County in August, 2005.

B. Hydrologic Criteria

Based on the minimal impact of off-site drainage on this parcel, and the relatively small size of the tributary drainage basins impacting the site, rational method hydrology was utilized for the project drainage analysis. In accordance with El Paso County drainage criteria, hydrologic calculations were based on the following assumptions:

• Design storm (minor)	5-year	
• Design storm (major)	100-year	
• Storm Distribution	SCS Type IIA (eastern Colorado)	
• 100-year, 24-hour rainfall	4.4 inches per hour (NOAA isopluvial map)	
• 5-year, 24-hour rainfall	2.6 inches per hour (NOAA isopluvial map)	
• Hydrologic soil type	B	
	C5	C100
• Runoff Coefficients – undeveloped areas:		
Forest	0.10	0.15
Meadow	0.25	0.35
• Runoff Coefficients - developed:		
Existing 0.5-acre residential lots	0.6	0.7
Proposed 2.5-acre residential lots	0.28	0.35

The majority of off-site and on-site areas are comprised of heavily wooded areas and small meadow areas. Composite runoff coefficients were generally calculated assuming 70 percent forest and 30 percent meadow areas. The proposed "C-values" for developed 2.5-acre lots were calculated based on the impervious area assumptions in Appendix B.

Hydrologic calculations are enclosed in Appendix B, and peak design flows are identified on the historic and developed drainage plans (Figures EX1, EX2, and D1, Appendix A). Runoff coefficients ("C"-values) were selected from Table 5-1 in the Drainage Criteria Manual. Rainfall intensities for each basin were derived from the El Paso County intensity-duration-frequency (IDF) curve based upon the basin time of concentration. Times of concentration were calculated utilizing the "Airport equation, with maximum overland flow lengths of 1,000 feet for undeveloped areas and 300 feet for developed areas. The "SCS upland equation" was used for channelized flow calculations.

IV. DRAINAGE FACILITY DESIGN

A. General Concept

Development of the proposed subdivision will require site grading and paving work, resulting in additional impervious areas across the site. The general concept for management of developed storm runoff is to provide positive drainage from the home sites to ditches along the internal roads within the subdivision, conveying runoff flows through the site. The street system has been designed to convey runoff by roadside ditches to cross culverts at low points in the road, consistent with existing drainage channels crossing the parcel. Natural drainage swales running across the property will be maintained, following historic drainage patterns. 20-foot drainage easements will be platted along the existing drainage swales to ensure that home sites keep an adequate setback from these channels. The majority of developed drainage from the site will be routed through two existing stock ponds near the easterly boundary of the site. These ponds will be upgraded to serve as stormwater detention ponds, releasing historic flows at the site boundary.

B. Specific Details

1. Existing Drainage Conditions

Historic drainage conditions are depicted in Figures EX1 and EX2. There are no existing drainage facilities serving the site, with the exception of two existing stock ponds at the easterly site boundary. While the existing ponds are not currently configured as stormwater detention ponds, the ponds likely provide some level of detention storage in their existing condition.

Basin A consists of the area along the southerly site boundary, which is impacted by developed runoff from the existing Red Rock Ranch Subdivision to the south (Basins OA1 and OA2). Runoff from Basins OA1 and OA2 combines with Basin A at Design Point #1, with historic peak flows of Q_5 = 32.3 cfs and Q_{100} = 73.4 cfs.

Basin B consists of the large drainage area extending from the west to the east property boundary following an existing well-defined drainage channel. This basin is impacted by off-site runoff from the national forest area west of the site (Basins OB1 and OB2). Runoff from Basins OB1, OB2, and OB3 combines with Basin B at Design Point #2, with historic peak flows of Q_5 = 26.3 cfs and Q_{100} = 65.6 cfs.

The middle of the site comprises Basin C, which sheet flows towards the easterly property boundary at Design Point #3, with historic peak flows of Q_5 = 5.2 cfs and Q_{100} = 13.0 cfs. Basin D consists of a small drainage area near the northerly site boundary, which flows to an existing swale at Design Point #4. Runoff from Basin OD1 combines with Basin D at Design Point #4, with historic peak flows of Q_5 = 1.1 cfs and Q_{100} = 2.6 cfs. Basin E is another small drainage area near the northerly site boundary, which sheet flows to Design Point #5, with historic peak flows of Q_5 = 1.2 cfs and Q_{100} = 3.0 cfs.

Historic drainage from this site flows easterly, ultimately reaching existing downstream channels feeding into Monument Creek on the southwest side of SH105. The existing channels in the downstream Forest View Estates Subdivision are generally in stable condition, and the impacts of developed flows from this site will be mitigated by on-site detention within the Red Rock Reserve Subdivision.

2. Developed Drainage Conditions

The developed drainage basins and projected flows are shown in the Developed Drainage and Erosion Control Plan (Sheet D1, Appendix A). The developed site has been divided into five on-site drainage basins and design points, as shown on the enclosed Drainage Plan.

Runoff from Basins OA1 will combine with Sub-Basin A1 at Design Point #A1, where a proposed culvert will convey these flows across Redstone Ridge Road. These flows will

continue flowing in a riprap channel to the proposed Culvert A3 crossing Red Rock Ranch Drive. Runoff from Basins OA1 and A1 combines with flows from Sub-basin A3 at Design Point #A3, where a proposed 36" RCP culvert will convey these flows across Red Rock Ranch Drive into Channel A4, and then into the proposed Detention Pond A. Within Sub-Basin A3, an existing eroded area along the frontage of Lot 17 (previously eroded from upstream irrigation discharges), will be filled and stabilized.

Runoff from Basin OA2 combines with Sub-Basin A2 at Design Point #A2, where a proposed culvert will convey the on-site developed flows across Red Rock Ranch Drive into Channel A2, which carries these flows into the detention pond. Flows downstream of Culvert A2 will be historic flows, so there will be no developed flow impact to areas southeast of this culvert.

Developed flows from Basins OA1-OA2 and A1-A4 combine at Design Point #1, with developed peak flows of Q_5 = 38.9 cfs and Q_{100} = 84.5 cfs. The proposed Detention Pond A mitigates the impacts of these developed flows prior to discharge at the easterly site boundary.

Runoff from Basins OD1 and D will be conveyed across Red Rock Ranch Drive through an 18" culvert (Culvert D1), combining with flows in Sub-Basin B1. Runoff from Basins OB1 and OB2 will combine with flows from Sub-basins OD1, D, C1, and B1 at Design Point #B1, where a proposed 42" RCP culvert crosses Red Rock Ranch Drive, flowing into Channel B2, which conveys these flows to Detention Pond B. Developed flows from Basins OB1-OB3, OD1, D1, C1, B1, and B2 combine at Design Point #2, with developed peak flows of Q_5 = 44.7 cfs and Q_{100} = 101.9 cfs.

Sub-basin C2 will continue to sheet flow towards the easterly property boundary at Design Point #3, with developed peak flows of Q_5 = 5.5 cfs and Q_{100} = 11.8 cfs. Based on the diversion of flows from Basin C1 to Detention Pond B, the developed flows at Design Point #3 will be lower than historic.

Basins OD1 and D will be diverted to drain to the southerly ditch of Red Rock Ranch Drive, combining with flows in Basin B1. As such, developed flow impacts at Design Point #4 will be eliminated. Basin E will continue to sheet flow to Design Point #5, with developed peak flows of Q_5 = 1.2 cfs and Q_{100} = 2.7 cfs.

The proposed extension of Red Rock Ranch Drive westerly into the Red Rock Reserve subdivision will require construction of a new culvert crossing west of the Spruce Road intersection. This culvert will convey off-site drainage from Basin OA3 northeasterly across Red Rock Ranch Drive, following historic drainage patterns. The proposed Culvert OA3 will consist of a double 36-inch RCP culvert. A riprap apron will be installed at the downstream end of this culvert to dissipate flows where the culvert drains to the existing grass-lined swale downstream.

C. Comparison of Developed to Historic Discharges

Based on the hydrologic calculations in Appendix C, the total developed flow from the site will exceed historic flow from the site. As previously discussed, the increase in developed flows will be mitigated through on-site detention ponds. The comparison of developed to historic discharges at key design points is summarized as follows:

Design Point	Historic Flow			Developed Flow			Comparison of Developed to Historic Flow (Q_5%/Q_{100}%)
	Area (ac)	Q_5 (cfs)	Q_{100} (cfs)	Area (ac)	Q_5 (cfs)	Q_{100} (cfs)	
1	43.6	32.3	73.4	44.7	38.9	84.5	120% / 115% (increase)
2	72.6	26.3	65.6	86.5	44.7	101.9	170% / 155% (increase)
3	13.8	6.6	16.2	5.5	5.5	11.8	83% / 73% (decrease)
4	2.4	1.1	2.6				(decrease)
5	3.0	1.2	3.0	0.9	1.2	2.7	100% / 90% (decrease)

D. Detention Ponds

The total developed storm runoff downstream of the proposed subdivision will be maintained at historic levels by routing flows through two proposed detention ponds to be created by upgrading existing stock ponds near the easterly site boundary. The proposed detention facilities have been sized to attenuate peak flows through the ponds, based on the difference between outflow and inflow hydrographs for both minor and major storm events. Pond outlet structures have been designed with multiple orifice openings to detain both minor and major storm events. The proposed Detention Pond A has been designed to "over-detain" to account for release of developed flows from Design Point 3.

The ponds were sized utilizing the "Intelisolve Hydraflow" software package (see routing analysis for each pond in Appendix D1 and D2), resulting in the following pond sizes:

Pond	Inflow (cfs)	Outflow (cfs)	Volume (ac-ft)	Outlet Structure
A	84.5	56.5	0.3	36-inch RCP w/ multiple orifices
B	101.9	65.4	1.3	30-inch RCP w/ multiple orifices

15-foot wide gravel maintenance access roads will be provided for all stormwater detention facilities. The proposed detention ponds will be privately owned and maintained by the subdivision HOA. In accordance with El Paso County drainage criteria, each pond has been designed to capture the water quality capture volume (WQCV), and each pond outlet structure has been designed with a perforated riser pipe to slowly release developed flows.

RED ROCK RESERVE SUBDIVISION

DEVELOPED DRAINAGE & EROSION CONTROL PLAN

JPS ENGINEERING
19 E. Willamette Ave.
Colorado Springs, CO
80903
PH: 719-477-9429
FAX: 719-471-0766

No.	REVISION	BY	DATE

HORZ. SCALE:	1"=100'	DRAWN:	MJP
VERT. SCALE:	N/A	DESIGNED:	JPS
SURVEYED:	LWA	CHECKED:	JPS
CREATED:	7/12/04	LAST MODIFIED:	3/14/06
PROJECT NO:	070401	MODIFIED BY:	MJP

SHEET: D1

Original Scale: 1"=100'
Contour Interval = 2 ft.

DRAINAGE LEGEND

- FILING LIMITS
- MAJOR BASIN BOUNDARY
- MINOR BASIN BOUNDARY
- EXISTING CONTOUR
- DRAINAGE CHANNEL
- PROPOSED FLOW DIRECTION ARROW
- PROPOSED CULVERT (RCP OR HDPE) W/ FLARED END SECTIONS
- PROPOSED SPOT ELEVATION
- PROPOSED ROAD GRADE
- DEVELOPED BASIN DESIGNATION
- DEVELOPED BASIN AREA (ACRES)
- DESIGN POINT
- Q_5 (cfs)
- Q_{100} (cfs) (DEVELOPED FLOW)
- RIPRAP (RR)
- VEHICLE TRACKING CONTROL PAD (VTC)
- STRAW BALE BARRIER @ 300' SPACING (STB)

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APPENDIX B

HYDROLOGIC CALCULATIONS

Table 6-6. Runoff Coefficients for Rational Method
(Source: UDFCD 2001)

Land Use or Surface Characteristics	Percent Impervious	Runoff Coefficients											
		2-year		5-year		10-year		25-year		50-year		100-year	
		HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D
Business													
Commercial Areas	95	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.87	0.87	0.88	0.88	0.89
Neighborhood Areas	70	0.45	0.49	0.49	0.53	0.53	0.57	0.58	0.62	0.60	0.65	0.62	0.68
Residential													
1/8 Acre or less	65	0.41	0.45	0.45	0.49	0.49	0.54	0.54	0.59	0.57	0.62	0.59	0.65
1/4 Acre	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
1/3 Acre	30	0.18	0.22	0.25	0.30	0.32	0.38	0.39	0.47	0.43	0.52	0.47	0.57
1/2 Acre	25	0.15	0.20	0.22	0.28	0.30	0.36	0.37	0.46	0.41	0.51	0.46	0.56
1 Acre	20	0.12	0.17	0.20	0.26	0.27	0.34	0.35	0.44	0.40	0.50	0.44	0.55
Industrial													
Light Areas	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Heavy Areas	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Parks and Cemeteries	7	0.05	0.09	0.12	0.19	0.20	0.29	0.30	0.40	0.34	0.46	0.39	0.52
Playgrounds	13	0.07	0.13	0.16	0.23	0.24	0.31	0.32	0.42	0.37	0.48	0.41	0.54
Railroad Yard Areas	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
Undeveloped Areas													
Historic Flow Analysis--Greenbelts, Agriculture	2	0.03	0.05	0.09	0.16	0.17	0.26	0.26	0.38	0.31	0.45	0.36	0.51
Pasture/Meadow	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Forest	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Exposed Rock	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Offsite Flow Analysis (when landuse is undefined)	45	0.26	0.31	0.32	0.37	0.38	0.44	0.44	0.51	0.48	0.55	0.51	0.59
Streets													
Paved	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Gravel	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Drive and Walks	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Roofs	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Lawns	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50

3.2 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the hydraulically most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations.

For urban areas, the time of concentration (t_c) consists of an initial time or overland flow time (t_i) plus the travel time (t_t) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time (t_i) plus the time of travel in a concentrated form, such as a swale or drainageway. The travel portion (t_t) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

$$t_c = t_i + t_t \quad \text{(Eq. 6-7)}$$

Where:

t_c = time of concentration (min)

t_i = overland (initial) flow time (min)

t_t = travel time in the ditch, channel, gutter, storm sewer, etc. (min)

3.2.1 Overland (Initial) Flow Time

The overland flow time, t_i, may be calculated using Equation 6-8.

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \quad \text{(Eq. 6-8)}$$

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5} \quad \text{(Eq. 6-9)}$$

Where:

V = velocity (ft/s)

C_v = conveyance coefficient (from Table 6-7)

S_w = watercourse slope (ft/ft)

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

* For buried riprap, select C_v value based on type of vegetative cover.

The travel time is calculated by dividing the flow distance (in feet) by the velocity calculated using Equation 6-9 and converting units to minutes.

The time of concentration (t_c) is then the sum of the overland flow time (t_i) and the travel time (t_t) per Equation 6-7.

3.2.3 First Design Point Time of Concentration in Urban Catchments

Using this procedure, the time of concentration at the first design point (typically the first inlet in the system) in an urbanized catchment should not exceed the time of concentration calculated using Equation 6-10. The first design point is defined as the point where runoff first enters the storm sewer system.

$$t_c = \frac{L}{180} + 10 \qquad \text{(Eq. 6-10)}$$

Where:

t_c = maximum time of concentration at the first design point in an urban watershed (min)

L = waterway length (ft)

Equation 6-10 was developed using the rainfall-runoff data collected in the Denver region and, in essence, represents regional "calibration" of the Rational Method. Normally, Equation 6-10 will result in a lesser time of concentration at the first design point and will govern in an urbanized watershed. For subsequent design points, the time of concentration is calculated by accumulating the travel times in downstream drainageway reaches.

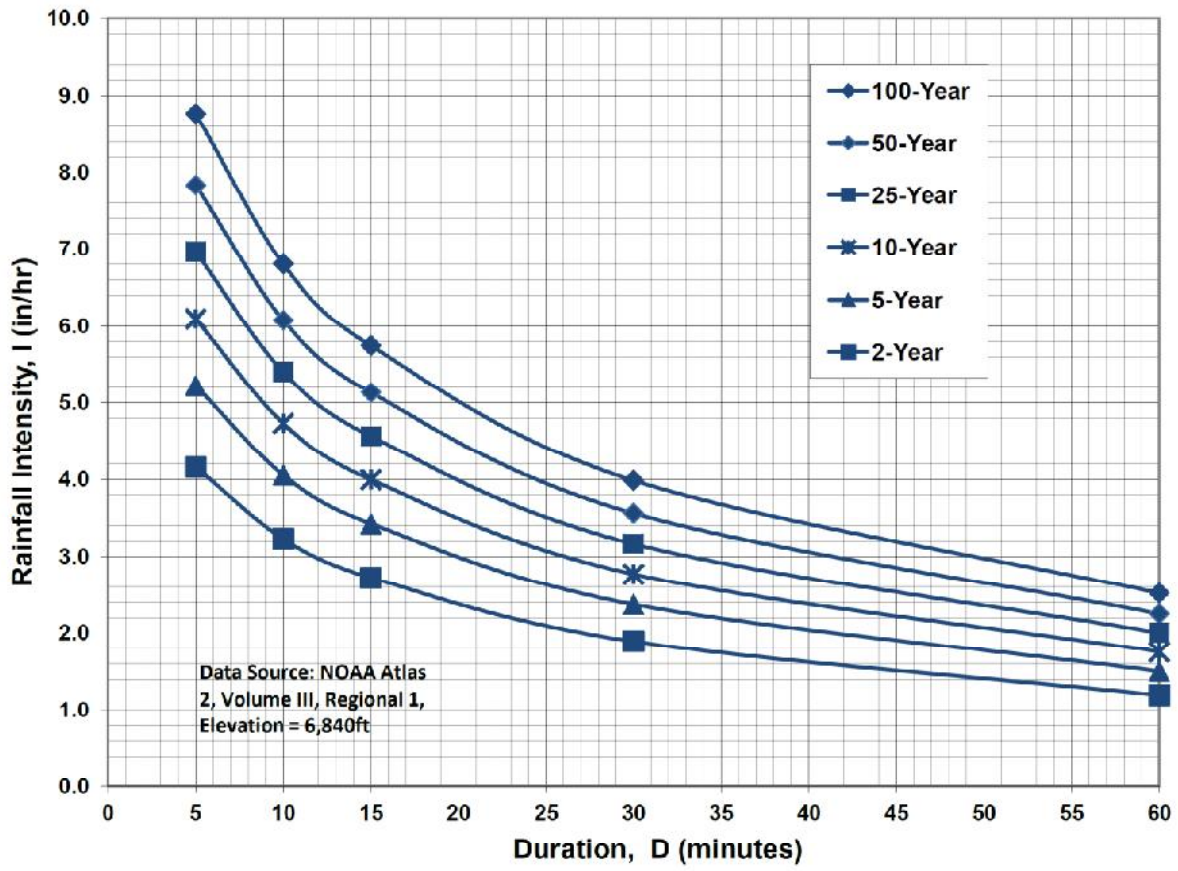
3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

3.2.5 Post-Development Time of Concentration

As Equation 6-8 indicates, the time of concentration is a function of the 5-year runoff coefficient for a drainage basin. Typically, higher levels of imperviousness (higher 5-year runoff coefficients) correspond to shorter times of concentration, and lower levels of imperviousness correspond to longer times of

Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency



IDF Equations

$I_{100} = -2.52 \ln(D) + 12.735$

$I_{50} = -2.25 \ln(D) + 11.375$

$I_{25} = -2.00 \ln(D) + 10.111$

$I_{10} = -1.75 \ln(D) + 8.847$

$I_{5} = -1.50 \ln(D) + 7.583$

$I_{2} = -1.19 \ln(D) + 6.035$

Note: Values calculated by equations may not precisely duplicate values read from figure.

RED ROCK RESERVE SUBDIVISION

COMPOSITE RUNOFF COEFFICIENTS - TYPICAL RURAL RESIDENTIAL AREA

DEVELOPED CONDITIONS

5-YEAR C VALUES

BASIN	TOTAL AREA (AC)	SOIL TYPE	AREA (%)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
2.5-ACRE LOTS	2.50	B	11.00	BLDG/DRIVEWAY	0.9	89.00	LAWN/MEADOW	0.08				0.170

100-YEAR C VALUES

BASIN	TOTAL AREA (AC)	SOIL TYPE	AREA (%)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
2.5-ACRE LOTS	2.50	B	11.00	BLDG/DRIVEWAY	0.96	89.00	LAWN/MEADOW	0.35				0.417

LOT 23, RED ROCK RESERVE SUBDIVISION
RATIONAL METHOD

DEVELOPED FLOWS

					Overland Flow			Channel flow										
BASIN	DESIGN POINT	AREA (AC)	C 5-YEAR	C 100-YEAR	LENGTH (FT)	SLOPE (FT/FT)	Tco [1] (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS [2] VELOCITY (FT/S)	Tt [3] (MIN)	TOTAL Tc [4] (MIN)	TOTAL Tc [4] (MIN)	INTENSITY [5] 5-YR (IN/HR)	INTENSITY [5] 100-YR (IN/HR)	PEAK FLOW Q5 [6] (CFS)	PEAK FLOW Q100 [6] (CFS)
OA1.1		2.1	0.170	0.417	100	0.200	6.3	245	15	0.135	5.51	0.7	7.0	7.0	4.66	7.82	1.63	6.72
A1.1		2.2	0.170	0.417	40	0.200	4.0	570	15	0.223	7.08	1.3	5.3	5.3	5.08	8.53	1.93	7.96
OA1.1,A1.1	1	4.3	0.170	0.417									8.4	8.4	4.40	7.38	3.21	13.24
A1.2	A1.2	1.3	0.170	0.417	40	0.200	4.0	435	15	0.14	5.61	1.3	5.3	5.3	5.09	8.55	1.08	4.46
OA1.1,A1.1,A1.2	2	5.6	0.170	0.417									8.4	8.4	4.40	7.38	4.15	17.09

1) OVERLAND FLOW Tco = (0.395*(1.1-RUNOFF COEFFICIENT)*(OVERLAND FLOW LENGTH^(0.5)/(SLOPE^(0.333))
2) SCS VELOCITY = C * ((SLOPE(FT/FT)^0.5)
C = 2.5 FOR HEAVY MEADOW
C = 5 FOR TILLAGE/FIELD
C = 7 FOR SHORT PASTURE AND LAWNS
C = 10 FOR NEARLY BARE GROUND
C = 15 FOR GRASSED WATERWAY
C = 20 FOR PAVED AREAS AND SHALLOW PAVED SWALES
3) MANNING'S CHANNEL TRAVEL TIME = L/V (WHEN CHANNEL VELOCITY IS KNOWN)
4) Tc = Tco + Tt
*** IF TOTAL TIME OF CONCENTRATION IS LESS THAN 5 MINUTES, THEN 5 MINUTES IS USED
5) INTENSITY BASED ON I-D-F EQUATIONS IN CITY OF COLORADO SPRINGS DRAINAGE CRITERIA MANUAL
$I_5 = -1.5 * \ln(Tc) + 7.583$
$I_{100} = -2.52 * \ln(Tc) + 12.735$
6) Q = CiA

APPENDIX C

HYDRAULIC CALCULATIONS

LOT 23, RED ROCK RESERVE SUBDIVISION
CHANNEL CALCULATIONS

CHANNELS - DEVELOPED FLOWS

CHANNEL	DESIGN POINT	SLOPE (FT/FT)	BOTTOM WIDTH (B, FT)	SIDE SLOPE (Z)	CHANNEL DEPTH (FT)	FRICTION FACTOR (n)	Q100 FLOW (CFS)	Q100 DEPTH (FT)	Q100 VELOCITY (FT/S)	TOP WIDTH (FT)	CHANNEL LINING
CHANNEL A1.1	1	0.120	0	4:1	2.0	0.030	13.2	0.6	7.9	5.2	**GRASS / ECB**
CHANNEL A1.2	A1.2	0.080	0	4:1	2.0	0.030	4.5	0.5	5.2	3.7	**GRASS / ECB**

1) Channel flow calculations based on Manning's Equation
2) n = 0.03 for grass-lined non-irrigated channels (minimum)
3) Vmax = 5.0 fps for 100-year flows w/ grass-lined channels
4) Vmax = 8.0 fps for 100-year flows w/ Erosion Control Blankets / Turf Reinforcement Mats (Eronet SC150 or equal)

Hydraulic Analysis Report

Project Data

Project Title: Project - Lot 23, Red Rock Reserve
Designer: JPS
Project Date: Friday, April 24, 2026
Project Units: U.S. Customary Units
Notes:

Channel Analysis: Channel Analysis - A1.1

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 4.0000 ft/ft
Longitudinal Slope: 0.1200 ft/ft
Manning's n: 0.0300
Flow: 13.2000 cfs

Result Parameters

Depth: 0.6457 ft
Area of Flow: 1.6679 ft^2
Wetted Perimeter: 5.3249 ft
Hydraulic Radius: 0.3132 ft
Average Velocity: 7.9140 ft/s **> 5 fps…..Use ECB Lining**
Top Width: 5.1659 ft
Froude Number: 2.4545
Critical Depth: 0.9248 ft
Critical Velocity: 3.8586 ft/s
Critical Slope: 0.0177 ft/ft
Critical Top Width: 7.40 ft
Calculated Max Shear Stress: 4.8353 lb/ft^2
Calculated Avg Shear Stress: 2.3455 lb/ft^2

Channel Analysis: Channel Analysis - A1.2

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 4.0000 ft/ft
Longitudinal Slope: 0.0800 ft/ft
Manning's n: 0.0300
Flow: 4.5000 cfs

Result Parameters

Depth: 0.4654 ft
Area of Flow: 0.8663 ft^2
Wetted Perimeter: 3.8377 ft
Hydraulic Radius: 0.2257 ft
Average Velocity: 5.1942 ft/s **> 5 fps…..Use ECB Lining**
Top Width: 3.7231 ft
Froude Number: 1.8976
Critical Depth: 0.6013 ft
Critical Velocity: 3.1114 ft/s
Critical Slope: 0.0204 ft/ft
Critical Top Width: 4.81 ft
Calculated Max Shear Stress: 2.3232 lb/ft^2
Calculated Avg Shear Stress: 1.1269 lb/ft^2

APPENDIX D

FIGURES

N

50' 0 50' 100'

ORIGINAL SCALE: 1"=50' (24"x36" SHEET)
CONTOUR INTERVAL: 2'

LEGEND

- FEMA 100-YEAR FLOODWAY
- FEMA 100-YR FLOODPLAIN
- PROPERTY BOUNDARY
- DRAINAGE BASIN BOUNDARY
- STREAMSIDE OVERLAY LIMITS
- 7420 PROPOSED CONTOUR
- 7420 EXISTING CONTOUR
- FLOWLINE
- FLOW DIRECTION ARROW
- 1 DESIGN POINT
- A / 2.6 AC BASIN DESIGNATION / BASIN AREA (ACRES)
- (E) EXISTING
- (P) PROPOSED

LOT 23, RED ROCK RESERVE SUBDIVISION
4619 REDSTONE RIDGE RD, MONUMENT, CO 80132

JPS ENGINEERING
19 E. Willamette Ave.
Colorado Springs, CO
80903
PH: 719-477-9429
FAX: 719-471-0766

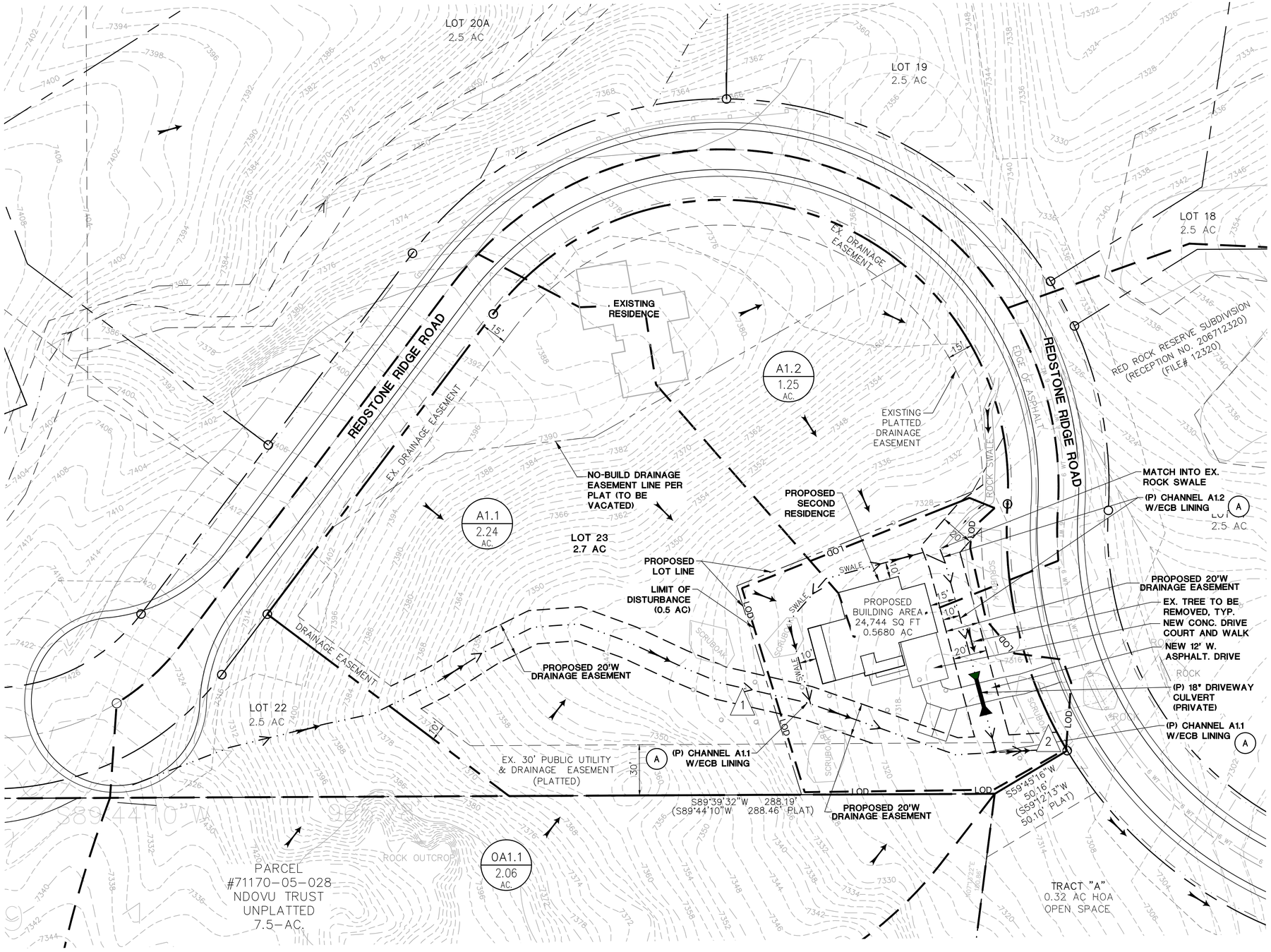
CALL UTILITY NOTIFICATION
CENTER OF COLORADO
1-800-922-1987
CALL 2 WORKING DAYS IN ADVANCE
BEFORE YOU DIG, GRADE, OR EXCAVATE
FOR THE MARKING OF UNDERGROUND
MEMBER UTILITIES.

No.	REVISION	BY	DATE

LOT 23 OFF-SITE DRAINAGE PLAN

HORZ. SCALE:	1"=50'	DRAWN:	PV
VERT. SCALE:	N/A	DESIGNED:	JPS
SURVEYED:	LWA	CHECKED:	JPS
CREATED:	03/10/26	LAST MODIFIED:	05/04/26
PROJECT NO:	070401	MODIFIED BY:	PV

SHEET: EX1.1



LEGEND

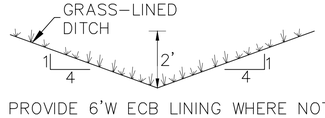
- PROPERTY BOUNDARY
- DRAINAGE BASIN BOUNDARY
- STREAMSIDE OVERLAY LIMITS
- 6520 PROPOSED CONTOUR
- 6520 EXISTING CONTOUR
- DRAINAGE CHANNEL/SWALE
- FLOW DIRECTION ARROW
- LOD LIMIT OF CONSTRUCTION/ DISTURBANCE
- 1 DESIGN POINT
- A / 2.6 AC BASIN DESIGNATION / BASIN AREA (ACRES)
- (E) EXISTING
- (P) PROPOSED
- GI GRATED INLET (18" NYOPLAST OR EQUAL)

BASIN SUMMARY TABLE

BASIN	Q_5 (CFS)	Q_{100} (CFS)
OA1.1	1.6	6.7
A1.1	1.9	8.0
A1.2	1.1	4.5

SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q_5 (CFS)	Q_{100} (CFS)
1	3.2	13.2
2	4.2	17.1



* PROVIDE 6'W ECB LINING WHERE NOTED

TYPICAL DRAINAGE CHANNEL (A)

NTS

BENCHMARK:

TOP OF THE 2-1/2" ALUMINUM CAP LS#6635 AT THE SOUTHEAST CORNER OF THE SOUTHWEST QUARTER OF THE SOUTHEAST QUARTER OF SECTION 8; ELEVATION 7212.60 (SOUTHEAST CORNER OF THE PROJECT)

LOT 23, RED ROCK RESERVE SUBDIVISION
4619 REDSTONE RIDGE RD, MONUMENT, CO 80132

LOT 23 DEVELOPED DRAINAGE PLAN

JPS ENGINEERING
19 E. Willamette Ave.
Colorado Springs, CO 80903
PH: 719-477-9429
FAX: 719-471-0766

CALL UTILITY NOTIFICATION CENTER OF COLORADO
1-800-922-1987
CALL 2 BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

No.	REVISION	BY	DATE

HORZ. SCALE:	1"=30'
VERT. SCALE:	N/A
SURVEYED:	LWA
CREATED:	03/10/26
PROJECT NO:	070401
DRAWN:	PV
DESIGNED:	JPS
CHECKED:	JPS
LAST MODIFIED:	05/07/26
MODIFIED BY:	PV

SHEET: D1.1